

## IMAGE SENSOR PACKAGE AND METHOD FOR MANUFACTURE THEREOF

Background of the Invention1. Field of the Invention

5           The present invention relates to an image sensor package and a method for manufacturing the same.

2. Description of the Related Art

10           Image sensor dies have a wide range of applications, which include applications in toys, digital cameras, camcorders, scanners, medical scopes, surveillance cameras and cellular phones. Generally, image sensor dies are used to process moving pictures or still pictures. Applications in cameras and cellular  
15           phones have brought an explosive increase of demand for image sensor dies. It is expected that such image sensor dies will become the most promising market for the next-generation semiconductor industry.

20           A conventional image sensor package including an image sensor die generally comprises a substrate on which the image sensor die is mounted, a conductive wire for electrically connecting the image sensor die to the substrate, an infrared blocking glass for blocking infrared rays, a barrel transmitting light to  
25           the image sensor die and having a plurality of lenses for adjusting a focus distance, and a mount for fixing the barrel to the substrate.

30           However, the large number of elements complicates the process of manufacturing the conventional image sensor package and increases the cost of manufacture. Specifically, in the conventional image sensor package, the barrel and the infrared blocking glass are provided as separate elements and the infrared blocking glass is  
35           independently mounted within the mount, thereby increasing the number of elements and complicating the manufacturing process.

In order to manufacture the conventional image sensor package, equipment for precisely handling a very small infrared blocking glass is necessary. Also, mounting the infrared blocking glass using such  
5 equipment prolongs the time of manufacturing.

In addition, when a barrel connecting process is performed over the infrared blocking glass, dust particles may easily lay on the infrared blocking glass. This will reduce the image recognition rate of the  
10 image sensor package.

#### Summary of the Invention

In accordance with one embodiment of the present invention, disclosed is an image sensor package and a  
15 method for manufacturing the same. The image sensor package comprises an image sensor die, a substrate, a support wall having screw threads on the outer peripheral surface thereof and a mount into which a barrel including a plurality of lenses and an infrared  
20 blocking glass is mounted. The screw threads formed on the outer peripheral surface of the support wall are engaged with those formed on the inner peripheral surface of the mount. At least one passive element is provided on the substrate at the outer peripheral side  
25 of the support wall, thereby increasing the packaging density of the image sensor package.

The present invention will be more apparent from the following detailed description taken in conjunction with the accompanying drawings.

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#### Brief Description of the Drawings

FIG. 1 is a cross-sectional view of an image sensor package constructed in accordance with one embodiment of the present invention;

35 FIG. 2 is a cross-sectional view of an image sensor package constructed in accordance with another embodiment of the present invention;

FIGs. 3A to 3H illustrate an exemplary sequence of operations that may be used to facilitate the fabrication of the image sensor package of FIG. 1; and

FIGs. 4A to 4I illustrate an exemplary sequence of operations that may be used to facilitate the fabrication of the image sensor package of FIG. 2.

Common reference numerals are used throughout the drawings and the detailed description to indicate the same elements.

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#### Detailed Description

Referring to FIG. 1, a cross-sectional view of an image sensor package 100 constructed in accordance with one embodiment of the present invention is illustrated.

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As shown in the drawing, the image sensor package 100 comprises an image sensor die 110 receiving external light and converting the received light to an electrical signal, a substrate 120 supporting the image sensor die 110 and relaying an electrical signal to or from an external device, a plurality of conductive wires 130 electrically connecting the image sensor die 110 to the substrate 120, a support wall 140 having a predetermined height and formed on the substrate 120 around the periphery of the conductive wires 130 and a mount 160 having a barrel 150 at the center thereof and coupled to the support wall 140.

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The image sensor die 110 has an approximately or completely planar photosensing surface 111 which receives external light and converts the received light into an electrical signal and a plurality of bond pads 112 at the peripheral side of the photosensing surface 111. Also, the image sensor die 110 has an approximately or completely planar non-photosensing surface 113 on the side opposite to the photosensing surface 111 and the bond pads 112.

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The substrate 120 includes an insulating layer 123 having an approximately or completely planar first

surface 121 to which the non-photosensing surface 113 of the image sensor die 110 is adhered by means of an adhesive 114 and an approximately or completely planar second surface 122 on the opposite side thereof. A  
5 plurality of electrically conductive patterns 124\_1 is formed on the first surface 121 of the insulating layer 123. Also, a plurality of electrically conductive patterns 124\_2 is formed on the second surface 122. The electrically conductive patterns 124\_1 and 124\_2 are  
10 connected by conductive vias 125 which penetrate into the insulating layer 123. The first surface 121 and the electrically conductive patterns 124\_1, excluding the wire bonding portions, are coated with a first protective layer 126\_1. Also, the second surface 122  
15 and the electrically conductive patterns 124\_2, excluding the soldering portions, are coated with a second protective layer 126\_2. The soldering portions are defined herein as ball lands 127.

The plurality of conductive wires 130 electrically  
20 connect the bond pads 112 formed on the image sensor die 110 to the substrate 120, and more particularly to the electrically conductive patterns 124\_1 formed on the first surface 121 of the insulating layer 123. The conductive wires 130 may be of aluminum, copper, gold,  
25 silver or an equivalent thereof. The material of the conductive wires 130 is not to be limited herein.

The support wall 140 having a predetermined height is formed on the first protective layer 126\_1 of the substrate 120 around the periphery of the conductive  
30 wires 130. The support wall 140 is made of a non-conductive material. Preferably, the support wall 140 should be higher than the loop height formed by the conductive wires 130. Also, the support wall 140 has a plurality of screw threads 141 on the outer peripheral  
35 surface thereof.

The mount 160 has a plurality of screw threads 161 which can be engaged with the screw threads 141 of the

support wall 140 on the inner peripheral surface thereof. Also, the mount 160 has an aperture 162 at its center corresponding to the photosensing surface 111 of the image sensor die 110. The barrel 150 with a  
5 plurality of lenses 151 and an infrared blocking glass 152 is received in the aperture 162. Since the infrared blocking glass 152 is mounted in the barrel 150 in advance and screw connection is made on the outer peripheral surface of the support wall 140, there is a  
10 low probability that particles will lay on the infrared blocking glass 152 or the photosensing surface 111 of the image sensor die 110 when the mount 160 is coupled to the support wall 140. The image sensor package 100 can adjust the focus of the barrel 150 according to the  
15 turning of the mount 160. In other words, when the mount 160 is turned to be coupled to the support wall 140, it is possible to adjust the distance between the barrel 150 and the image sensor die 110 and the focus distance by controlling the turning of the mount 160.

20 At least one passive element 170 is provided on the electrically conductive patterns 124\_1 formed on the first surface 121 of the substrate 120, i.e., the insulating layer 123, at the outer peripheral side of the support wall 140, thereby increasing the packaging  
25 density of the image sensor package 100. Also, at least one passive element 170 is provided on the electrically conductive patterns 124\_1 at the inner peripheral side of the support wall 140 (not shown). A flexible circuit 180 is connected to the soldering portions, i.e., ball  
30 lands 127 of the electrically conductive patterns 124\_2 formed on the second surface 122 of the insulating layer 123, by solders 190 so that the image sensor package 100 can be easily connected to an external device.

35 Referring to FIG. 2, a cross-sectional view of an image sensor package 200 constructed in accordance with

another embodiment of the present invention is illustrated.

As shown in the drawing, the image sensor package 200 comprises a semiconductor die 210, a substrate 220 electrically connected to the semiconductor die 210, a mount 230 adhered to the substrate 220 at the peripheral side of the semiconductor die 210, an image sensor die 240 electrically connected to the mount 230 and a barrel 250 engaged into the mount 230 above the image sensor die 240.

The semiconductor die 210 has an approximately or completely planar first surface 211 and an approximately or completely planar second surface 212 on the opposite side thereof. A plurality of bond pads 213 is formed on the second surface 212. A conductive bump 214 is bonded to each bond pad 213. The conductive bump 214 can be made of, and is not limited to, gold (Au), silver (Ag), solder (Sn/Pb) or an equivalent thereof. The semiconductor die 210 can be a DSP (Digital Signal Processor) or a memory. Since the semiconductor die 210 is provided in addition to the image sensor die 240, modularization of the image sensor package 200 can be achieved.

The substrate 220 includes an insulating layer 223 having two opposing surfaces, i.e., a first surface 221 and a second surface 222 which are approximately or completely planar. A plurality of electrically conductive patterns 224\_1 is formed on the first surface 221 of the insulating layer 223. Also, a plurality of electrically conductive patterns 224\_2 is formed on the second surface 221. The electrically conductive patterns 224\_1 and 224\_2 are connected by conductive vias 225 which penetrate into the insulating layer 223. The conductive bumps 214 of the semiconductor die 210 are electrically connected to the electrically conductive patterns 224\_1. The first surface 221 and the electrically conductive patterns

224\_1, excluding the portions connected to the conductive bumps 214, are coated with a first protective layer 226\_1. Also, the second surface 222 and the electrically conductive patterns 224\_2, 5 excluding the soldering portions, are coated with a second protective layer 226\_2. The soldering portions refer to ball lands 227.

Further, an underfill 228 is filled between the semiconductor die 210 and the substrate 220 in order to 10 improve the mechanical bond strength between the semiconductor die 210 and the substrate 220 and prevent the corrosion of the conductive bumps 214.

The mount 230 having a predetermined height is fixed to the substrate 220 at the peripheral side of 15 the semiconductor die 210, i.e., to the first protective layer 226\_1 of the insulating layer 223. The mount 230 includes a support plate 232 which extends inward to a predetermined length and which has an aperture 231 of a predetermined diameter at the center 20 thereof. The diameter of the aperture 231 of the support plate 232 is equal to or greater than a photosensing surface 241 of the image sensor die 240. An electrically conductive pattern 233 is formed on the lower surface of the support plate 232 and the inner 25 wall of the mount 230 below the support plate 232. The electrically conductive pattern 233 is electrically connected to the electrically conductive patterns 224 (electrically conductive patterns 224\_1, 224\_2) of the substrate 220. In addition, a plurality of screw 30 threads 234 is formed on the inner wall of the mount 230 above the support plate 232.

The image sensor die 240 has an approximately or completely planar photosensing surface 241, which receives external light and converts the light into an 35 electrical signal. A plurality of bond pads 242 are formed on the image sensor die 240 at the peripheral side of the photosensing surface 241. Also, a plurality

of conductive bumps 243 which are electrically connected to the electrically conductive pattern 233 of the support plate 232 are formed on the bond pads 242. In order to improve the mechanical bond strength  
5 between the image sensor die 240 and the support plate 232 and prevent the corrosion of the conductive bumps 243, an underfill 244 is filled between the image sensor die 240 and the support plate 232. In addition, the image sensor die 240 has an approximately or  
10 completely planar non-photosensing surface 245 on the side opposite to the photosensing surface 241 and the bond pads 242. The non-photosensing surface 245 of the image sensor die 240 is spaced at a predetermined distance from the first surface 211 of the  
15 semiconductor die 210.

The barrel 250 includes a plurality of lenses 251 and an infrared blocking glass 252 therein. A plurality of screw threads 253 formed at the outer peripheral surface of the barrel 250 can be engaged with screw  
20 threads 234 of the mount 230. Accordingly, it is possible to adjust the focus distance between the barrel 250 and the image sensor die 240 by turning the barrel 250 in a predetermined direction.

In addition, at least one passive element 260 is  
25 provided on the electrically conductive patterns 224\_1 formed on the first surface 221 of the insulating layer 223 at the outer peripheral side of the mount 230, thereby increasing the packaging density of the image sensor package 200. Also, a flexible circuit 270 is  
30 further connected to the ball land 227 of each electrically conductive pattern 224\_2 formed on the second surface 222 of the insulating layer 223 by a solder 280 so that the image sensor package 200 can be easily connected to an external device.

35 Referring to FIGs. 3A to 3H, an exemplary sequence of operations that may be used to facilitate the



fabrication of the image sensor package of FIG. 1 is illustrated.

As shown in the above drawings, a method for manufacturing the image sensor package 100 comprises the operations of: providing an image sensor die 110, providing a substrate 120, connecting a passive element 170; fixing a support wall 140, attaching the image sensor die 110, bonding wires 130, connecting a mount 160 having a barrel 150 mounted therein and connecting a flexible circuit 180.

FIG. 3A shows the operation of providing the image sensor die 110.

As shown in the drawing, the image sensor die 110 has an approximately or completely planar photosensing surface 111, which receives external light and converts the light into an electrical signal. A plurality of bond pads 112 is formed at the peripheral side of the photosensing surface 111. Also, an approximately or completely planar non-photosensing surface 113 is formed on the side opposite to the photosensing surface 111 and the bond pads 112.

FIG. 3B shows the operation of providing the substrate 120.

As shown in the drawing, the substrate 120 includes an insulating layer 123 having an approximately or completely planar first surface 121 to which the non-photosensing surface 113 of the image sensor die 110 is adhered by means of an adhesive 114 and an approximately or completely planar second surface 122 on the opposite side thereof. A plurality of electrically conductive patterns 124\_1 is formed on the first surface 121 of the insulating layer 123. Also, a plurality of electrically conductive patterns 124\_2 is formed on the second surface 122. The electrically conductive patterns 124\_1 and 124\_2 are connected by conductive vias 125 which penetrate into the insulating layer 123. The first surface 121 and the electrically

conductive patterns 124\_1, excluding the wire bonding portions, are coated with the first protective layer 126\_1. Also, the second surface 122 and the electrically conductive patterns 124\_2, excluding the soldering portions, are coated with the second protective layer 126\_2. The soldering portions refer to ball lands 127.

FIG. 3C shows the operation of connecting the passive element 170.

As shown in the drawing, at least one passive element 170 is provided on the electrically conductive patterns 124\_1 formed on the first surface 121 of the insulating layer 123 at the outer peripheral side of the support wall 140. Since the passive element 170 is not located in an external device to which the image sensor package is connected, but formed in the image sensor package itself, the packaging density of the image sensor package can be increased.

FIG. 3D shows the operation of fixing the support wall 140.

As shown in the drawing, the support wall 140 having a predetermined height is secured onto the first protective layer 126\_1 of the substrate 120, i.e., insulating layer 123. Also, the support wall 140 has a plurality of screw threads 141 at the outer peripheral surface thereof.

FIG. 3E shows the operation of attaching the image sensor die 110.

As shown in the drawing, the image sensor die 110 is attached to the first surface 121 of the insulating layer 123 inside the support wall 140 formed on the substrate 120 by the adhesive 114 provided on the non-photosensing surface 113.

FIG. 3F shows the operation of bonding the wires 130.

As shown in the drawing, the plurality of bond pads 112 formed on the image sensor die 110 are

electrically connected to the plurality of electrically conductive patterns 124\_1 formed on the first surface 121 of the insulating layer 123 of the substrate 120 by the plurality of conductive wirés 130.

5           FIG. 3G shows the operation of connecting the mount 160 with the barrel 150 mounted therein.

          As shown in the drawing, the mount 160 has a plurality of screw threads 161 at the inner peripheral surface thereof to be engaged with the screw threads 10  
141 formed at the outer peripheral surface of the support wall 140. Also, the mount 160 has an aperture 162 at its center corresponding to the photosensing surface 111 of the image sensor die 110. The barrel 150 having a plurality of lenses 151 and an infrared  
15 blocking glass 152 is received in the aperture 162. The mount 160 can be tightly coupled to the support wall 140 if turned sufficiently in a predetermined direction. It is possible to optimize the focus distance between the barrel 150 and the image sensor die 110 by  
20 appropriately turning the mount 160.

          FIG. 3H shows the operation of connecting the flexible circuit 180.

          As shown in the drawing, the flexible circuit 180 extending outward to a predetermined length is  
25 connected to the ball land 127 of each electrically conductive pattern 124\_2 formed on the second surface 122 of the insulating layer 123 by a solder 190 so that the image sensor package 100 can be easily connected to an external device. The image sensor package 100  
30 according to the present invention is thus completed. The flexible circuit 180 can be connected to an external device, such as a digital camera or a cellular phone.

          Referring to FIGs. 4A to 4I, an exemplary sequence  
35 of operations that may be used to facilitate the fabrication of the image sensor package of FIG. 2 is illustrated.

As shown in the above drawings, a method for manufacturing the image sensor package 200 comprises the operations of: providing a semiconductor die 210 with a plurality of conductive bumps 214 attached thereto, providing a substrate 220, connecting a passive element 260, electrically connecting the semiconductor die 210 to the substrate 220, providing an image sensor die 240 having a photosensing surface 241 and a plurality of conductive bumps 243, providing a mount 230 with a support plate 232 and electrically connecting the mount 230 to the image sensor die 240, mounting the mount 230 over the substrate 220, mounting a barrel 250 into the mount 230 and connecting a flexible circuit 270.

FIG. 4A shows the operation of providing the semiconductor die 210.

As shown in the drawing, the semiconductor die 210 has an approximately or completely planar first surface 211 and an approximately or completely planar second surface 212 on the opposite side thereof. Also, a plurality of bond pads 213 is formed on the second surface 212. A conductive bump 214 is bonded to each bond pad 213.

FIG. 4B shows the operation of providing the substrate 220.

As shown in the drawing, the substrate 220 includes an insulating layer 223 having two opposing surfaces, i.e., a first surface 221 and a second surface 222 which are approximately or completely planar. A plurality of electrically conductive patterns 224\_1 is formed on the first surface 221 of the insulating layer 223. Also, a plurality of electrically conductive patterns 224\_2 is formed on the second surface 221. The electrically conductive patterns 224\_1 and 224\_2 are connected by conductive vias 225 which penetrate into the insulating layer 223. The first surface 221 and the electrically conductive patterns

224\_1, excluding the portions connected to the conductive bumps 214, are coated with the first protective layer 226\_1. Also, the second surface 222 and the electrically conductive patterns 224\_2, 5 excluding the soldering portions, are coated with the second protective layer 226\_2. The soldering portions refer to ball lands 227.

FIG. 4C shows the operation of connecting the passive element 260.

10 As shown in the drawing, at least one passive element 260 is provided on the electrically conductive pattern 224\_1 formed on the first surface 221 of the insulating layer 223. Since the passive element 260 is not located in an external device to which the image 15 sensor package is connected, but formed in the image sensor package itself, the packaging density of the image sensor package can be increased.

FIG. 4D shows the operation of connecting the semiconductor die 210.

20 As shown in the drawing, the conductive bumps 214 attached to the semiconductor die 210 are placed to be in contact with the electrically conductive patterns 224\_1 formed on the first surface 221 of the insulating layer 223 and then secured onto the electrically 25 conductive patterns 224\_1 by reflowing. Subsequently, an underfill 228 is filled between the semiconductor die 210 and the substrate 220 in order to improve the mechanical bond strength between the semiconductor die 210 and the substrate 220 and prevent the corrosion of 30 the conductive bumps 214.

FIG. 4E shows the operation of providing the image sensor die 240.

As shown in the drawing, the image sensor die 240 has an approximately or completely planar photosensing 35 surface 241, which receives external light and converts the light into an electrical signal. A plurality of bond pads 242 are formed on the image sensor die 240 at

the peripheral side of the photosensing surface 241. Also, a plurality of conductive bumps 243 is formed on the bond pads 242. In addition, the image sensor die 240 has an approximately or completely planar non-photosensing surface 245 on the side opposite to the

FIG. 4F shows the operation of providing the mount 230 and connecting the mount 230 to the image sensor die 240.

As shown in this drawing, the mount 230 has a substantially H-shaped cross-section. The mount 230 has a support plate 232 which extends inwardly to a predetermined length and which has an aperture 231 of a predetermined diameter at the center thereof. The diameter of the aperture 231 of the support plate 232 is equal to or greater than the photosensing surface 241 of the image sensor die 240. An electrically conductive pattern 233 is formed on the lower surface of the support plate 232 and the inner wall of the mount 230 below the support plate 232. In addition, a plurality of screw threads 234 is formed on the inner wall of the mount 230 above the support plate 232.

The conductive bumps 243 attached to the image sensor die 240 are placed to be in contact with the electrically conductive pattern 233 of the mount 230 and then fixed to the electrically conductive pattern 233 by reflowing. Subsequently, an underfill 244 is filled between the image sensor die 240 and the support plate 232 in order to improve the mechanical bond strength between the image sensor die 240 and the support plate 232 and prevent the corrosion of the conductive bumps 243.

FIG. 4G shows the operation of mounting the mount 230 over the substrate 220.

As shown in the drawing, the mount 230 having a predetermined height is fixed to the substrate 220 at the peripheral side of the semiconductor die 210, i.e.,

to the first protective layer 226\_1 of the insulating layer 223. The electrically conductive pattern 233 is electrically connected to the electrically conductive patterns 224-1 formed on the first surface 221 of the insulating layer 223.

FIG. 4H shows the operation of mounting the barrel 250 into the mount 230.

As shown in the drawing, the barrel 250 has a plurality of screw threads 253 at the outer peripheral surface thereof to be engaged with the screw threads 234 formed at the inner periphery of the mount 230. The barrel 250 integrates a plurality of lenses 251 and an infrared blocking glass 252 therein. The barrel 250 is inserted into the mount 230 and turned sufficiently in a predetermined direction so that the screw threads 253 and 234 can be engaged with each other. It is possible to optimize the focus distance between the barrel 250 and the image sensor die 240 by appropriately turning the barrel 250.

FIG. 4I shows the operation of connecting the flexible circuit 270.

As shown in the drawing, the flexible circuit 270 extending outward to a predetermined length is further connected to the electrically conductive patterns 224\_2 formed on the second surface 222 of the insulating layer 223 by a solder 280 so that the image sensor package 200 can be easily connected to an external device. The image sensor package 200 according to the present invention is thus completed.

This disclosure provides exemplary embodiments of the present invention. The scope of the present invention is not limited by these exemplary embodiments. Numerous variations, whether explicitly provided for by the specification or implied by the specification, such as variations in structure, dimension, type of material and manufacturing process, may be implemented by one skilled in the art in view of this disclosure.